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RHEOLOGICAL CHANGES IN IRRADIATED CHICKEN EGGS

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ABSTRACT

Pathogenic bacteria may cause foodborne illnesses. Humans may introduce pathogens into foods during production, processing, distribution and or preparation. Some of these microorganisms are able to survive conventional preservation treatments. Heat pasteurization, which is a well established and satisfactory means of decontamination/disinfection of liquid foods, cannot efficiently achieve a similar objective for solid foods. Extensive work carried out worldwide has shown that irradiation is efficient in eradicating foodborne pathogens like *Salmonella spp.* that can contaminate poultry products. In this work Co-60 gamma irradiation was applied to samples of industrial powder white, yolk and whole egg at doses between 0 and 25 kGy. Samples were rehydrated and the viscosity measured in a Brookfield viscosimeter, model DV III at 5, 15 and 25^{0}C. The rheological behaviour among the various kinds of samples were markedly different. Irradiation with doses up to 5 kGy, known to reduced bacterial contamination to non-detectable levels, showed almost no variation of viscosity of irradiated egg white samples. On the other hand, whole or yolk egg samples showed some changes in rheological properties depending on the dose level, showing the predominance of whether polimerization or degradation as a result of the irradiation. Additionally, irradiation of yolk egg powder reduced yolk color as a function of the irradiation exposure implemented. The importance of these results are dicussed in terms of possible industrial applications.

KEYWORDS: Gamma irradiation, powder eggs products, viscosity.

INTRODUCTION

As international trade with egg products increases, the transmission of diseases by such commodities tends to become an ever increasing problem. The conventional sterelization and heat pasteurization have unfavourable effects on some of the properties of these products, for instance, consistency. The need for new and suitable preservation methods to extend the shelf life and, even more important, make the products bacteriologically safe, is therefore evident. Irradiation is an alternative process to the employment of heat or gaseous chemical for treatment which are being banned from food applications (Pszcola, 1993-Knabel, 1995). Much effort has been concentrated on the application of ionizing radiation to the preservation of food (IAEA, 1963). The effects of irradiation against salmonellae bacteria in eggs and others products are relatively known (Thronley, 1963).

Irradiation up to 10kGy did not produce measurable changes in acidity, vitamins B_1 or B_2 content (Katusin-Razem et al., 1989). Ionizing radiation is an attrative alternative to heat pasteurization for egg products. Irradiation of eggs with either 2 or 3kGy reduced bacterial contamination to non-detectable levels (Tellez et al.,1995). Irradiation of undiluted egg white above 3 - 4 kGy caused visually observable physical changes of the product, such as increased viscosity, and that could be the limiting factor for complete radiation sterilization of liquid whole egg and egg products (Fossum, 1973). Studies carried out to investigate the effect of gamma irradiation on the physicochemical and functional properties of proteins from frozen liquid egg products showed that gamma irradiation caused extensive losses in the internal quality in shell eggs, but the functional properties of the egg white protein, including whipping, emulsifying and gelling properties, were either maintained or significantly improved (Ma, et al.,1993).

The aim of this work was to study the rheological radiation effects of Co-60 gamma irradiation on samples of industrial powder white, yolk and whole egg.

MATERIALS AND METHODS

Materials

Commercial samples obtained from manufacturers were used: whole egg, egg yolk, egg white. Samples weighing ~50g were distributed in polyethylene pouches. Samples were processed in duplicate.

Irradiation

Irradiations were carried out with ^{60}Co gamma rays, with doses of 0kGy, 5kGy, 15kGy and 25kGy at room temperature. After irradiation, samples were rehydrated to a 10% (w/w) concentration.

Viscosymetry

The viscosity was measured in a digital Brookfield viscosimeter, model DV III Progammable Rheometer. Viscosity measurements were performed at 5.0, 15.0 and 25.0°C., Viscosity behavior of all rehydrated powder egg white, yolk egg and whole egg samples were measured with spindle SC4-18.

RESULTS AND DISCUSSION

In the present study, the rheological behavior of the 3 dried egg products was caracterized by plotting viscosity versus doses at 5.0, 15.0 and 25.0°C.

The apparent viscosity did not significantly changed in the irradiated egg white and yolk egg but some changes could be seen in the whole egg. When the temperature increased, the viscosity decreased. When a dose of 5kGy was employed, an increase of the viscosity became apparent, remaining constant at 15kGy and at 25kGy a further small increase of the viscosity occurred. This was possible to be seen by using two different methods for evaluation of viscosity: a shear stress fixed at 7 dynes/cm^2, for egg white and yolk, and 10 dynes /cm^2 for whole egg as it can be seen at Figs.1, 2 and 3 for the 3 temperature assayed. Another approach was based on the Bingham model, as plotted in Figs 4, 5 and 6.

The egg white viscosity remained almost constant when irradiated with doses from 0 to 25kGy, being the maximum difference less than 10% at 5.0 and 15°C, and no differences at all at 25°C for any dose value, no matter the method employed to calculate the viscosity.

On the other hand, egg yolk showed some differences in the rheological properties depending on the dose level. At 5.0 and 15.0 °C for the dose of 25kGy there is a significant increase (about 20 and 40%) in the viscosity only when the Bingham model was used.

Whole egg rheological behavior was not the sum of the behavior of the white and yolk egg. When either on of the methods of the fixed shear stress or the Bingham model was used, the viscosity varied from 20 to 37% among the irradiated and the unirradiated samples for all the temperatures assayed.

Irradiation of yolk egg powder reduced yolk color as a function of the radiation exposure (see Fig. 7). The color of yolk light petroleum extract faded as a function of the dose, being the peak at 445nm completely absent when the dose went up to 1.5kGy. This is in agreement with the results from other authors who described that egg carotenoids are very suceptible to irradiation, as compared to carotenoids of some dry plant materials (Katusin-Ranzem et al. 1989).

According to Ma et al., 1990, yolk proteins seem to be more suceptible to radiation-induced breakdown than egg white proteins do. Also, dehydrated egg products are more susceptible to peroxidation due to an unfavorable high surface to volume ratio (Addis, 1986). The dominant radiation-induced chemical changes in whole egg powder and egg yolk powder irradiated in air are degradative changes of lipidic components: the accumulation of lipid hydroperoxides and the destruction of carotenoids. For the food industry, it is also important the deterioration of protein functionality such as foaming power of the egg white and emulsifying capacity of the egg yolk.

The influence of Co-60 gamma radiation on the chemical and organoleptic properties of solid whole egg and solid egg yolk and egg white was studied by others to provide a basis for assessing the feasibility of the radicidation of *Salmonella* in egg powder (Katusin-Razem et al., 1989). The dose of 2.4kGy was described as adequate for a *Salmonella* inactivation factor of 10^3 (Matic, 1990), being at the same time below both the induction dose to produce extensive degradation and the threshold dose of 3kGy to produce noticeable sensorial changes.

The results of the present work showed that there were some changes in viscosity for whole egg powder but not for egg white powder nor yolk, there was the color disappearence in the yolk as a function of dose. It seems that the sort of changes caused by radiation will not impaire its technological use and at the same time, radiation will provide a safer food product.

Figure 1: Shear Stress Fixed - 5.oC

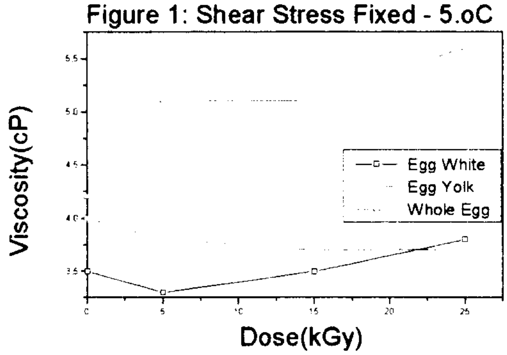


Figure 2: Shear Stress Fixed - 15.oC

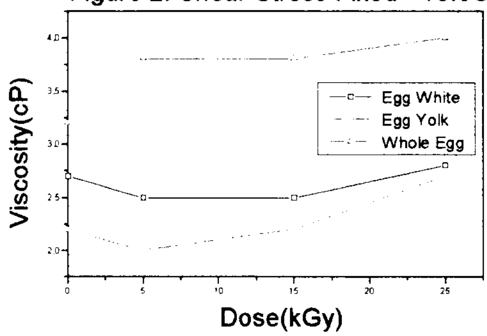


Figure 3: Shear Stress Fixed - 25.oC

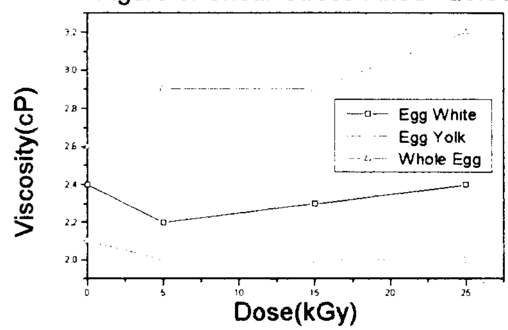


Figure 4: Bingham model - 5.oC

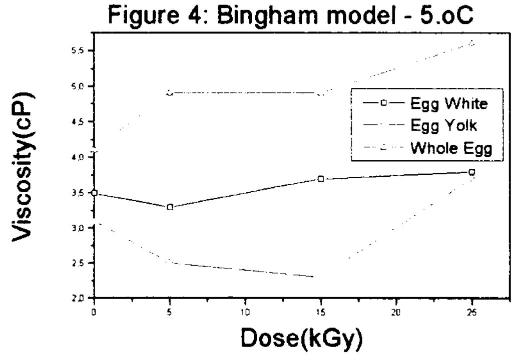


Figure 5: Bingham model - 15.oC

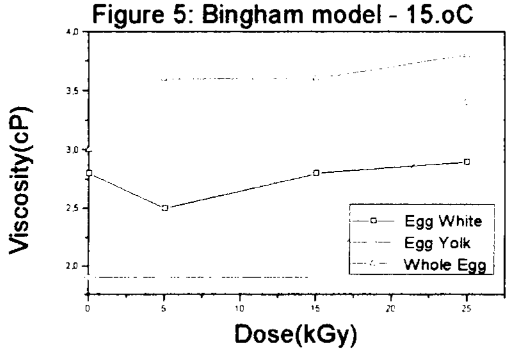


Figure 6: Bingham model - 25.oC

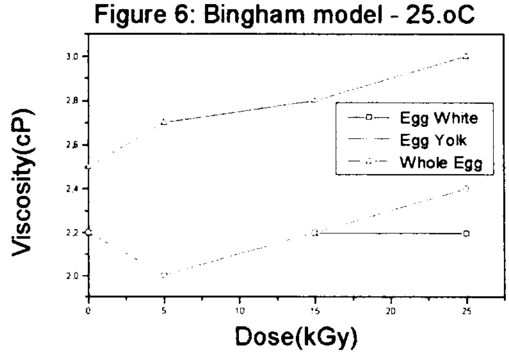
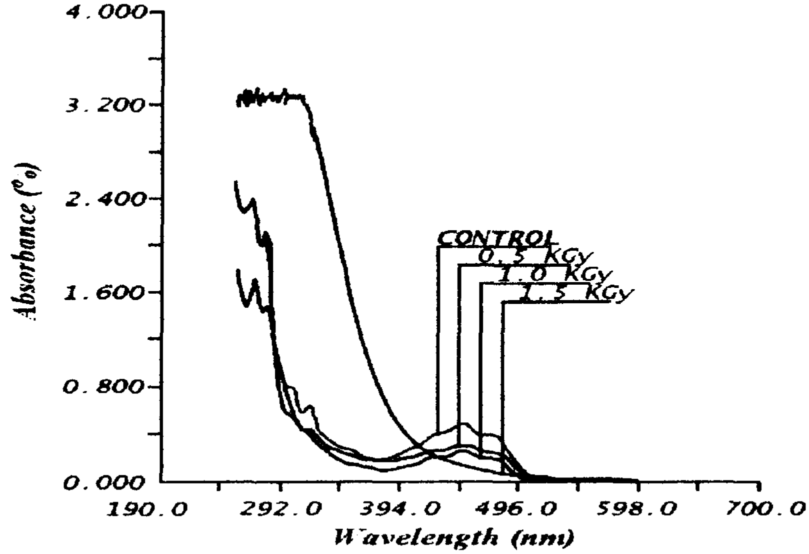


Figure 7: Absorbance (%) x Wavelength (nm)



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